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The Apple and Thorn Skeletonizer

By B. A. Porter and Philip Garman.

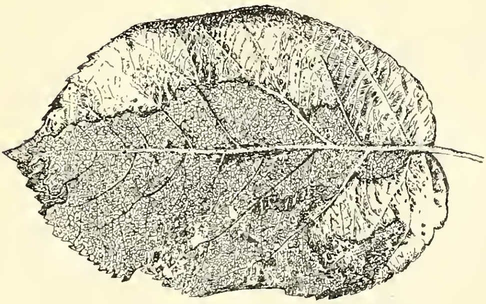

Figure 1. A skeletonized apple leaf.

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CONNECTICUT AGRICULTURAL EXPERIMENT STATION

OFFICERS AND STAFF

February, 1923

The Apple and Thorn Skeletonizer

Hemerophila pariana (Clerck)

BY

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AND

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INTRODUCTION.

In August and September, 1922, numerous brown and defoliated apple trees in Connecticut caused much comment. Later, inquiries were frequent regarding the "little triangular black bugs" that were common everywhere, especially on window screens. These comments and inquiries were caused by the appearance of an insect, the apple and thorn skeletonizer, known to entomologists as *Hemerophila pariana* (Clerck), and the "bugs" seen on screens were tiny moths, the adult form, in which stage they probably pass the winter. Like many of our pests, the insect has found its way here from Europe and, being unchecked by its usual enemies, has multiplied abundantly.

In view of the importance of this new addition to our list of insect pests, the writers have made a study of its life history, and the information obtained, although incomplete in some respects, is here presented.

The work of the senior author was carried on at the field station maintained for the study of fruit insects by the U. S. Bureau of Entomology at Wallingford. This station is under the general direction of Dr. A. L. Quaintance of the Bureau, and work is con-

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* Note: Dr. Porter, who has been in charge of the U. S. Bureau of Entomology Field Station at Wallingford, Conn., has studied this insect and has written the major portion of this paper. Dr. Garman of this Station has also made rearings and observations on this insect independently of Dr. Porter. At my suggestion they have put their notes together in the preparation of this bulletin. [W. E. BRITTON.]

ducted in co-operation with the Connecticut Agricultural Experiment Station at New Haven.*

History and Distribution.

This insect has been known to European entomologists for over 160 years, and frequent reference is made to it in Old World entomological literature. The species occurs throughout western Europe except the extreme southern part, and is recorded as far north as Norway, in many parts of eastern and southern European Russia, and in Turkestan in western Asia.

In August, 1917, Dr. E. P. Felt discovered that the insect was present in Westchester County, N. Y., in the lower Hudson River Valley. For the next two or three years the skeletonizer spread gradually to the northward and eastward. In the fall of 1920 it was found in Connecticut at Greenwich and Stamford, and was reported by Dr. Britton in his Annual Report for 1920 and in the Proceedings of the Connecticut Pomological Society for the same year.

Since 1920 the spread of the pest seems to have gained in momentum, and in Dr. Britton's 1921 Report it was mentioned as occurring in all parts of the State except Windham County. The infested area now includes the Hudson River Valley as far north as Albany, practically the entire State of Connecticut, and parts of western Massachusetts. During October large numbers of moths were noted at Amherst, Mass., and the insect will probably be found in southern New Hampshire and Vermont the coming year. The spread from the point where the skeletonizer was first noted has been almost wholly to the northward and eastward, since it does not seem to have extended its range very far into New Jersey.

In March of 1922 the insect was also reported in Northern Japan, where its life history is similar to that in Connecticut.

Importance.

Since its arrival, the skeletonizer has caused serious damage in many parts of Connecticut, especially in small home orchards and in orchards which were not carefully sprayed. Many unsprayed trees were seriously damaged before midsummer last year, and by

*During the summer of 1922 the senior author was ably assisted in the life history studies by Mr. Stanley W. Bromley, then a Field Assistant in the Bureau, and now a graduate student at the Massachusetts Agricultural College. Thanks are here extended to Mr S. A. Rohwer, Mr. R. A. Cushman and Dr. J. M. Aldrich, of the Bureau of Entomology, for the identification of parasite material reared from the skeletonizer. Hearty thanks are also due Mr. B. H. Walden of the Station, for assistance in preparing the illustrations for publication.

late August all the leaves on many of them were brown and dry, falling early in September. Plate IV, a, shows a tree which was injured by an unusually severe infestation. Late in August nearly every leaf on this tree had been totally skeletonized, although most of the larvae were not more than two-thirds grown. With famine staring them in the face, many of the caterpillars left their depleted feeding ground in search of fresh food, spinning down on threads and crawling here and there. So many larvae laid threads over the same ground that the trunk of the tree became enclosed in a web similar to a huge tent caterpillar nest. Early in September most of the leaves on this tree were falling, and by the middle of the month it was bare. Similar injury was done in many parts of the State, especially on roadside trees and in smaller orchards. This injury to the foliage throughout the season, which in extreme cases means complete defoliation by September or even earlier, weakens the tree, lessens the amount of reserve food stored, and reduces the vitality of the blossom buds for the coming season.

Commercial growers will have little to fear from this insect, as the routine spray applications will ordinarily keep the pest from getting a start in the orchard. The future importance of the skeletonizer cannot be safely predicted, but it is to be hoped that before long it may be brought under control by climatic conditions or by its natural enemies, and will take its place among our native and long established pests. The infestation in southwestern Connecticut is reported by one observer as being less severe in 1922 than in 1921, which may be taken by the optimistic to indicate the future trend of the infestation.

Common Name.

In most American accounts the pest has been called the "apple and thorn skeletonizer". Although this common name is not entirely satisfactory, no attempt will be made here to suggest a new one. However, throughout this paper the insect is referred to for the most part simply as the "skeletonizer".

Food Plants.

In Europe the skeletonizer is recorded as feeding on apple, thorn, pear, mountain ash, birch, one species of plum, and possibly willow. Apple seems to be the preferred food plant, and many accounts speak of it solely as an apple pest and make no mention of other hosts.

In the United States it has been noted chiefly on apple, to a lesser extent on thorn and pear, and in one instance on sweet cherry, but it does not seem to have been found on any of the other host plants listed in Europe.

A similar injury occurred on gray and other birches in New England the past season, which was attributed by many persons to this insect. The cause of the injury to the birches, however, is a native insect, known as the "birch leaf skeletonizer." (*Bucculatrix canadensisella* Chambers). Outbreaks of this species have occurred at intervals of about ten years since 1892.

Synonymy.

This insect has been known to entomologists under a number of scientific names during the past century and a half. Among these are the following:

Phalaena (Tortrix) pariana Clerck
1759—Icones Insectorum, t. 10, f. 9.

Pyralis pariana (Clerck)
1794—Fab., Ent. Syst., III 2, p. 277, No. 148.

Hemerophila pariana (Clerck)
1806—Hübner, Tentamen.

Anthophila lutosa Haworth
1812—Lep. Britt., III, p. 472, No. 4.

Choreutis pariana (Clerck)
1826—Hübner, Verzeichniss Bekannten Schmetterlinge, p. 373.

Asopia parialis Treitschke
1829—Schmett. Europe, VII, p. 159.

Simaethis pariana (Clerck)
1829—Stephens, Catal., II, p. 161, No. 6782.

Hemerophila pariana (Clerck)
1900—Fernald, C. H., Can. Ent., 32, p. 236.

Xylopoda pariana (Clerck)
1903—Tutt, J. W., Ent. Rec. and Journ. of Var., 15, p. 242.

Descriptions.

The following brief outline will give a general idea of the appearance of the insect in its successive stages.

The form in which the skeletonizer does its damage to the apple foliage is that of a small caterpillar. When newly hatched it measures about one-twenty-fifth of an inch in length, and is a pale yellowish green. When full grown it has become nearly half an inch in length, and is yellowish green with numerous prominent black spots. After feeding is completed, a long narrow white cocoon about three-fourths of an inch to an inch in length is constructed in a fold of an apple leaf or elsewhere, and from this the adult emerges in due time. The moth is more or less triangular in shape when resting, brown or dark gray in color, usually with a purplish tinge. It has a very characteristic attitude, the wings usually being held in an oblique position, slanting upwards from the fore part of the body at an angle of about 30° with the surface on which it

is resting. The eggs are somewhat hemispherical, about one-sixtieth of an inch in diameter, and are pale yellowish green, with a brownish ring which usually develops before hatching.

More detailed descriptions of the different stages follow:

The Egg—

Sub-hemispherical in shape, often slightly longer than wide; measuring as follows: length—.39 mm. to .44 mm., average .41 mm.; width—.33 mm. to .44 mm., average .38 mm.; height—.19 mm. to .28 mm., average .23 mm. The partially flattened side is usually placed next the surface to which the egg is applied. It is soft, thin shelled, finely sculptured, with fine lines radiating from a point in the center of the rounded surface of the egg. When first laid the eggs are pale green; after a few days they take on a slight yellowish tinge, and many of them show a brownish ring which has a diameter about half or more of the diameter of the egg, and which varies in width, being sometimes narrow, and sometimes broad enough to occupy the greater part of the convex surface.

The Larva—

First Instar—Length, newly hatched—about .8 mm.; length, full fed—2.0 mm.; width of head—.17 mm. to .22 mm.; average, .18 mm. Body distinctly annular. Head, pale yellow brown, posterior lateral margin with a dark line. Thoracic legs and prolegs a translucent pale watery green.

Second Instar—General color pale yellowish green with dark tubercles. Length, full fed—3.5 mm.; width, head—.30 mm. to .33 mm.; average .33 mm. Head, light yellowish brown; ocelli and posterior lateral margin dark; tips of mouth parts, brown. Tubercles raised, dark, conspicuous. Legs and prolegs, pale, translucent.

Third Instar—Very similar to preceding instar, the dark tubercles becoming larger. Length, full fed—6.0 to 7.0 mm.; width, head—.52 mm. to .61 mm.; average, .55 mm. Head, light yellowish brown; ocelli and posterior lateral margin dark; tips of mouth parts, brown; upper part of head usually with two dusky spots. Legs, dusky distally; prolegs, slender, pale, translucent.

Fourth Instar (Full grown)—Length, full fed—10 mm. to 12 mm.; width, head—.88 mm. to .96 mm.; average, .90 mm. Yellowish green with prominent black tubercles. Head, pale brown; posterior lateral edge, ocelli, and a narrow line at edge of mouth parts, black; often a pair of dusky spots on upper front of head. The median dorsal area, also a round lateral area on each segment,

a more yellowish green; tubercles large, prominent, shining black, finely lined. Ventral surface paler; last two joints of thoracic legs dusky, the next to the last especially so, rest of legs about concolorous with body; prolegs pale, slender, tubular, with a complete circle of hooks at the tip of all except the posterior. See figure 2, a.

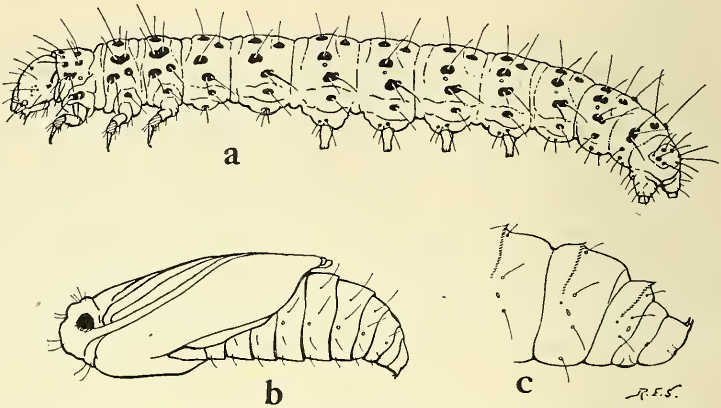

Figure 2. Apple and thorn skeletonizer. a. larva; b. female pupa; c. caudal extremity of male pupa, all greatly enlarged. Drawing lent by U. S. Bureau of Entomology.

The Pupa—

Length—5.0 mm. to 5.8 mm., average, 5.4 mm.; width at widest point—1.6 mm. to 1.9 mm.; average, 1.8 mm. Blunt at the ends. When newly formed is a light yellowish brown, with the outline of antennae, legs, wing pads, abdominal segments, and spiracles darker; eyes reddish. Later the entire pupa becomes darker, the head and abdominal segments 9-10 becoming nearly black; and the anterior portions of the meso-and metathorax, legs, and tips of antennae, more dusky than the rest of the pupa. On the anterior part of dorsal abdominal segments 3-8 in the male and 3-7 in the female is a single row of very fine, short spines, which in living specimens are often telescoped under the margin of each preceding segment. Segment 10 has two short, dorsal spines. Body with a few fine setae. The abdominal segments beyond the middle are very movable, and when disturbed the pupa moves the tip of the abdomen vigorously. See figure 2, b and c.

The Moth—

The moth is extremely variable. The predominant color, however, is dark reddish brown, often with a purplish tinge. Marginal scales of the wings nearly always dark brown, but the color

of the front wings is often relieved by an indefinite pale band (see Plate II, b and d), and wavy black lines. Frequently there are three or four white spots along the costal margin of the front wing, but the whole may be uniform brown or gray with spots or bands or stripes indistinct. Hind wings with a pale stripe on the costal margin which extends from the base of the wing slightly beyond the middle. The labial palpi consist of three segments, of which the third or terminal segment is three-fourths the length of the middle one. They are clothed with brown or white-tipped scales and extend beyond the head the length of the terminal segment. The wings below are mostly grayish in appearance, the costal margins of the front wings with conspicuous pale spots.

Body clothed with brown scales above except on sides of the abdomen where they are gray-tipped. Venter of abdomen and legs with gray-tipped scales, the tarsal segments with white scales at tip.

Length of body, 4.5 to 5 mm.; length of front wings, 5 mm.; wing-spread, 11-13 mm.

Observations in 1922.

While definite proof is lacking as to the stage in which the skeletonizer passes the winter, our observations indicate that, for the most part, hibernation occurs in the adult stage. Moths were noted in the field near Wallingford on April 16th and April 26th, and egg-laying evidently begins as early as the leaves appear, since larvae were found in various stages during May, and cocoons were spun as early as May 28th. A second generation followed soon after the first, larvae of this brood being present in the latter part of June, and some of them reaching maturity by the middle of July.

OVIPOSITION.

From this point, our life history studies are more complete, due to the increasing abundance of the skeletonizers, and to the fact that moths were induced to lay eggs in captivity, providing abundant material in all stages. This was accomplished by placing fairly large numbers of moths (usually forty or more) in glass battery jars, supplying them with a dilute sugar solution in tufts of cotton, and providing apple foliage on which to place the eggs. On emergence, the moths are apparently not ready to oviposit, as no eggs were laid in any of the cages until the fifth day, and in one cage none were laid until the tenth day after the moths had left the cocoons. While a few are laid on the upper surface of the leaves, the majority of the minute, green, sub-hemispherical eggs are placed on the lower surface, usually next the midrib or a larger vein, often being tucked partly under it. Usually the flattened

side of the egg is placed next the surface on which it is laid, though occasionally the egg is placed on edge among a mass of leaf hairs. Ordinarily laid singly, the eggs when numerous may touch each other or overlap slightly. Not all are laid at one time, as with some species of insects, but they mature a few at a time over an extended period. After the moths commenced laying, eggs were deposited daily for two to three weeks. In the five jars used for second brood oviposition the average number of eggs recorded per moth in each jar was 52, 52, 76, 80, and 94, respectively, and no doubt some additional eggs were overlooked, tiny and inconspicuous as they are. Possibly more eggs are laid normally in the field than it was possible to obtain in captivity. Most of the moths lived at least two or three weeks, and most of them continued alive several weeks after egg-laying stopped, the maximum length of life recorded being forty-two days for a female, and forty-eight days for a male.

INCUBATION OF EGGS.

As the embryo larva develops, the egg turns from a pale green to a slightly yellowish green, and a brownish ring appears in the convex surface. As hatching time approaches, the form of the larva may be very faintly seen through the thin shell of the egg, and the ocelli show as dark red dots. During the summer, the eggs hatch about a week after being laid.

FEEDING HABITS.

On hatching, the tiny pale green larvae wander for a while over the lower surface of the leaf, feeding a little here and there, but soon settle down in one spot, sometimes several in company, and eat away small patches of the lower leaf surface. Over the feeding area is spun a loosely woven layer of silk, which soon becomes filled with dark bits of waste matter. The skeletonizer larvae pass rapidly through four stages or *instars*, shedding their skins at the close of each. After the first molt, numerous dark dots appear on the upper side of the body; these become more and more conspicuous with each succeeding instar. When about one-third grown, usually during the second instar, the larvae desert the original feeding areas on the lower surface of the leaves, and migrate to the upper side. There a light web of silk is spun across from opposite edges of the leaf, usually near the base or the tip, drawing the two edges of the leaf partly together. Under this web the larva feeds on the leaf tissue, consuming all except the opposite epidermis and the veins. Often several larvae of various sizes may be found under a single web, especially when they are abundant. In many cases a partially skeletonized leaf will be deserted for a fresh one nearby. When disturbed, the larvae

wriggle vigorously and drop on a fine silken thread. When nearly full grown, they often spin down in the same way, especially if the food supply is becoming depleted due to excessive numbers of the voracious caterpillars.

THE COCOONING PERIOD.

After feeding for three weeks or more, the larvae become full grown, and make preparations for their coming transformation. The cocoon is usually constructed in an angle or fold of a leaf, often along the midrib, sometimes in the last leaf fed upon, but more often in another. Besides apple leaves, numerous other places may be used for cocooning, such as cracks in buildings, leaves of various weeds, and so on. The cocoon is white, about three-fourths of an inch long and rather narrow. The cocoon proper is enclosed in an outer one, which consists of a double layer of silk, stretched between the opposite sides of the fold or curl of the leaf, with a smaller amount of silk woven next to the leaf itself. The inner cocoon is spindle shaped, pointed at the ends, a little shorter than the outer cocoon and considerably narrower, and, like the outer one, is composed of a double layer of silk. Both ends are open, and the last larval skin, cast off when the pupa was formed, is often pushed out into the space between the two parts of the cocoon. (Plate I, b.)

THE PUPA STAGE.

Within forty-eight hours after the cocoon is started, its construction is complete, and the larva has thrown off its skin to assume the form of the *pupa*, a less active stage in which no feeding is done, and in which the transformation to the moth form takes place.

The pupa is less than one-fourth of an inch in length, not more than one-third the length of the inner cocoon, is brownish in color and rather blunt at the ends. The rear half of the body is quite flexible, and when disturbed, the pupa wriggles back and forth the length of the cocoon. In summer the pupal stage is passed through rapidly. With the first and second generations the entire period from the spinning of the cocoon to the appearance of the moth averaged less than twelve days, while with the third generation the process was retarded by cooler weather, and the moths emerging late in November had spent more than six weeks in the cocoon. As time for emergence approaches, the pupa becomes darker. When the moth is about to emerge, the pupa wriggles its way through the cocoon, and forces almost its entire body out of one end. Then the skin bursts, and the moth appears.

HABITS OF THE MOTHS.

The moths seem to be inactive at night, but are very active in the daytime, especially if the weather is warm. They are great lovers of flowers, and when they are flying in great numbers, are to be found in abundance on flowers of all kinds. In the vicinity of Wallingford, the moths have been noted on the flowers of wild carrot, goldenrod, tansy, yarrow, cultivated zinnias, calliopsis and many others. After the flowers have been killed by the frost, the moths seem to pay no further attention to them. The moths became extremely abundant during the latter part of September. Moths alighting on window screens were noted everywhere, and as many as thirty-two were counted on one screen at one time.

DISSEMINATION OF THE MOTHS.

The most rapid dissemination seems to occur in the moth stage. During October immense numbers of moths were observed at Amherst, Mass., seemingly more than could have emerged nearby, judging from the infestation in the immediate vicinity. Presumably many of these moths had come from the more heavily infested areas in Connecticut at times when a strong wind was blowing from the south or southwest. This seems the simplest way of accounting for the rapid spread of the species across the States of Connecticut and Massachusetts within a period of not more than three years.

FOURTH GENERATION.

During a period of unusually warm weather the first few days in October, a few of the third brood moths laid eggs, both in insectary cages and in the field. After an incubation period of 10 to 12 days, these eggs hatched, but sharp freezes the 19th and 21st of October killed nearly all the apple foliage, cutting off the food supply before many of these larvae had passed the first instar.

HIBERNATION.

The stage in which the species passes the winter seems to be in doubt. Mention is made in English entomological literature of the collection of the moths from roof thatch in very late fall and in very early spring. In German publications the statement is found that probably both pupae and adults winter over. In Wallingford attempts to carry both stages through the winter of 1921-22 failed. In 1922, the emergence from pupae of the third generation was very nearly complete, although the last moths to emerge did not leave the cocoons until late November. An examination of 158 cocoons collected at random near the Wallingford station on November 24th yielded only one living pupa, while examination of

a large number at New Haven yielded no live examples. Evidently the greater part, if not all, of the insects will pass the winter of 1922-23 as adults. Probably the moths which were seen in such numbers on windows and screens in the fall were in search of satisfactory places to spend the winter. Of 104 moths which emerged from September 5th to 15th, and which were kept in glass cages, less than 20 per cent. had died by the latter part of November. Examination of these February 21, as well as those in other cages, showed that about 15 per cent. were still alive. It seems almost certain, therefore, that some of the moths will survive the winter.

Under different seasonal and weather conditions, the last brood of larvae might complete their feeding later in the fall, and pupation might occur so late that many individuals would pass the winter in the cocoons and emerge in the early spring. In November of 1922, however, moths emerged from cocoons spun as late as October 8th.

LIFE HISTORY DATA.

Table 1 gives in condensed form the information secured at the Wallingford station on the seasonal history of this insect during 1922. The records for the first two generations are incomplete, but estimates have been made of the dates when egg-laying and hatching probably occurred. With these two generations the information regarding cocooning, pupation, and emergence was secured from material in all larval stages collected in the field when the most advanced larvae were about to spin cocoons. Data for the third and fourth generations were obtained from material reared from eggs laid in the insectary.

The periods during which the different biological events occurred are represented graphically in Fig. 2. As a guide to effective application of control measures, the periods when larvae of the successive generations were present on the trees are shown in the lower part of the graph. The dates when the usual spray applications should have been made that particular season are also shown.

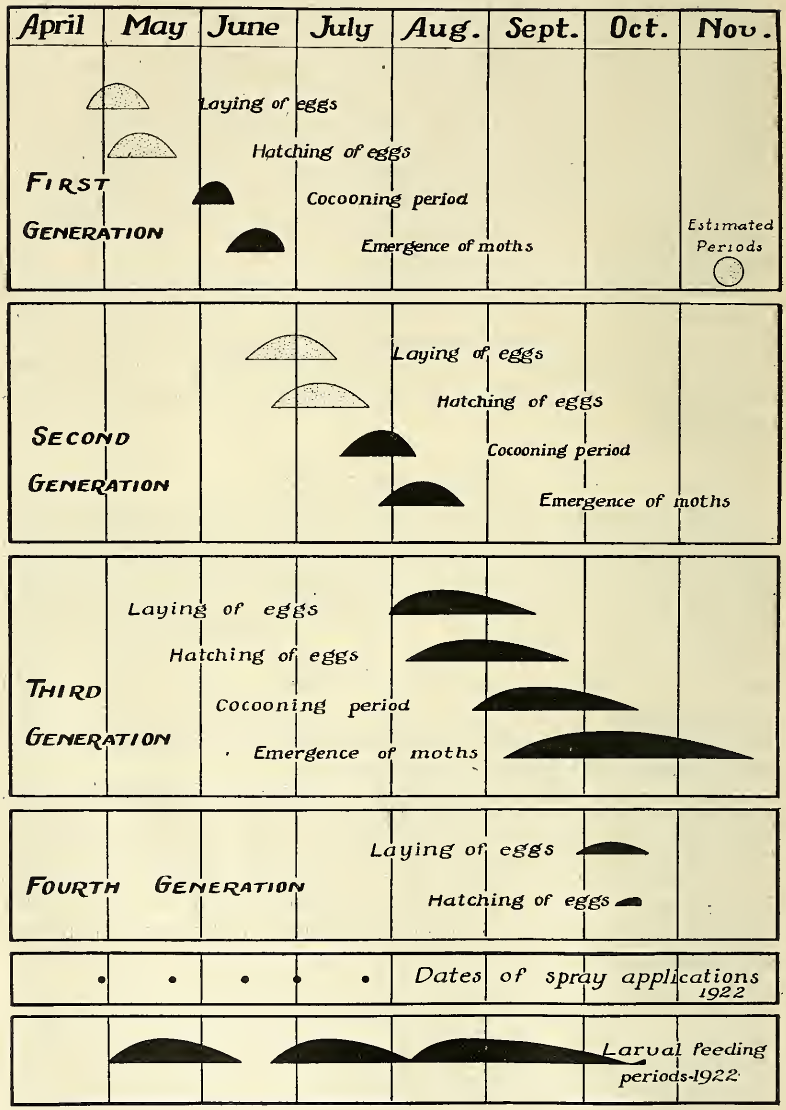

Figure 3. Chart of the life history of the apple and thorn skeletonizer. Stippled areas are estimated periods.

Table I. Condensed Seasonal History Notes. Wallingford, Conn., 1922.

Generation.	Stage.	Period When Present. First.	Maximum.	Last.	Duration of Stage—Days. Maximum.	Minimum.	Average.	Remarks.
1st	Egg	(April 25)*	(May 10)	(May 20)	..	..	...	
	Larva	(May 1)	May 28	June 11	..	..	...	
	Pupa	May 29	June 7	June 24	14	8	11.2†	
	Moth	June 7	(June 24)	(July 24)	..	..	...	
2nd	Egg	(June 14)	(July 7)	(July 20)	..	..	...	
	Larva	(June 20)	July 14	Aug. 7	..	..	...	
	Pupa	July 15	July 25	Aug. 20	16	8	11.8†	
	Moth	July 25	(Aug. 15)	Sept. 30	..	..	...	
3rd	Egg	(July 31)	(Aug. 20)	(Sept. 25)	9	5	6.9	
	Larva	Aug. 5	Aug. 30	Oct. 16	38	17	23.2	
	Pupa	Aug. 23	Sept. 5	? ?	21	9	13.5†	Early part 3rd generation
					45	14	21.2	Latter part 3rd generation
	Moth	Sept. 5	(Sept. 30)	....	..	..	...	
4th	Egg	Sept. 28	Oct. 9	Oct. 19	..	..	...	
	Larva	Oct. 9	Oct. 19	Oct. 19	..	..	...	Freeze killed foliage Oct. 19

* Approximate date. † Includes time spent as a larva within cocoon—approximately 1.5 days.

Natural Enemies.

A number of natural enemies have been observed preying on the skeletonizer. An encouraging feature of the work of parasites has been the wide variety of forms which seem to be adapting themselves to this new host, although most of them have been reared in small numbers. One Russian publication dealing with this insect (abstracted in Rev. Appl. Ent., I, p. 489) states that a high percentage of parasitism occurred in the region under discussion. It is to be hoped that a similar condition will be speedily reached in this country, although as yet the combined efforts of all enemies have not been sufficient to keep pace with the rapid multiplication of the host. A report from Fairfield County in 1922, however, indicates that the skeletonizer infestation has been somewhat less severe than in the preceding year, which we may hope is due to an increase of natural enemies.

Mr. Bromley noted a number of chipping sparrows which were apparently feeding on the skeletonizer larvae. He also observed a spider feeding on a moth, and another moth which had been captured by an ambush bug of the family *Phymatidae*. An immature Pentatomid, probably a species of *Podisus*, was observed sucking the juices from a small larva.

The following parasites have been reared in Connecticut*:

Habrobracon gelechiae (Ashmead). Parasitic on or in the larva which collapses before becoming full grown. Collected at Bantam.

Dioctes obliteratus (Cresson). Oviposition in the two-thirds to nearly full grown host larva; emergence from the host cocoon. Reared from Wallingford material, and has also been reared from the skeletonizer in New York State.

Sagaritis sp. Life history similar to that of *Dioctes*. Reared at Wallingford.

Exochus propinquus Cresson. Oviposition in nearly full grown larva; emergence from host cocoon. Wallingford.

Epiurus indagator (Cresson). Oviposition in full grown larva; emergence from host cocoon. Wallingford and Southington.

Dibrachys boucheanus (Ratzeburg). This omnivorous parasite oviposits in the host pupa in the cocoon. Wallingford.

Exorista pyste Walker. The pearly white eggs of this species are placed on the nearly full grown host larvae. Cocooning and pupation occur as usual, but the pupa is killed by the parasite maggot from which the fly later emerges. New Haven and Walling-

**D. boucheanus* determined by Mr. S. A. Rohwer; other Hymenopterous parasites determined by Mr. R. A. Cushman; all Dipterous parasites determined by Dr. J. M. Aldrich.

ford, and has also been reported from New York State as parasitizing the skeletonizer.

Phorocera tortricis Coquillett. Life history similar to that of *Exorista pyste*. Wallingford.

Nemorilla maculosa Meigen. A single individual emerged from a host pupa. Probably oviposition or larviposition occurs in or on host larva. Wallingford.

The following parasites have been recorded from Europe:

Angitia glabricola Holmgren; *Mesochorus pectoralis* Ragonot; *Microgaster* sp.; *Phygadeuon* sp.; *Thryptocera crassicornis* Meigen.

Control.

A review of the feeding habits of the skeletonizer larvae will show that the pest should be easily controlled by the use of arsenate of lead, the standard poison for leaf-chewing insects. For a week or more after hatching, the young larvae feed on the under sides of the leaves, but before they have become very large, and before extensive feeding has been done, they migrate to the upper surfaces, and complete their feeding there. Often one leaf will be deserted for another nearby. If the lower surfaces of the leaves are well coated with poison before the eggs hatch, the newly hatched larvae should be easily killed. If the upper sides of the leaves are thoroughly covered, the larvae on migrating there from their first feeding grounds will consume much of this poison.

These assumptions were confirmed by laboratory experiments carried on at the Wallingford station. On August 12th, 24 newly hatched larvae were placed on each of two apple branches sprayed with powdered arsenate of lead at the rate of one pound in 50 gallons of water, special care having been taken to cover the under sides. Twenty-four newly hatched larvae were similarly placed on each of two unsprayed branches. An examination of the foliage nine days later showed that 34 out of the 48 placed on the unsprayed twigs had survived, whereas none could be found on the sprayed. With third and fourth instar larvae, nearly one hundred per cent. kill was obtained with arsenate of lead at the rate of one pound of the powdered form in 50 gallons of water. Only one larva survived the treatment, this individual spinning its cocoon four days after being placed on the sprayed foliage. Equally good control was obtained with the use of only half this strength of the poison. From these experiments it is evident that a thorough application of arsenate of lead at the usual strength, and even at a lesser strength, will kill all but the nearly full grown larvae, which apparently may not consume enough poison before cocooning to kill them.

It is next necessary to consider the proper time for the applications. The periods during which the larvae are to be found feeding on the foliage are shown graphically in Fig. 3. A single application early in the feeding period of each generation should give satisfactory control. During 1922 these points were reached approximately as follows: 1st generation, about May 15th, during the latter part of the blooming period of the apple; 2nd generation, about July 4th, about seven weeks after apple blossom time; 3rd generation, about August 20th, approximately 14 weeks after apple blooming.

In practice, the commercial fruit grower will get fairly good control of the skeletonizer if he follows the usual spray schedule recommended for the control of other orchard insects. A majority of the first brood of skeletonizer larvae will be poisoned by the arsenate of lead in the so-called pink and calyx applications, and fairly good control should result from the latter application alone. The second brood should be well controlled by the first apple maggot spray early in July. Where this application is unnecessary, enough poison will probably remain from the spray for codling moth control (put on the middle of June or three or four weeks after the calyx spray) to kill at least the early part of the second generation of skeletonizer larvae. The later part of the same brood will be poisoned by the second brood codling moth spray, applied the latter part of July, approximately ten weeks after the calyx application. Enough of this last mentioned application will probably be still present during August, when the third brood of skeletonizer larvae appears. Fruit growers should be on the lookout for the third brood during August, and if an infestation threatens, due to a migration of moths into the orchard, it may be worth while to make a special application as soon as larvae are present in numbers. In 1922, this occurred soon after the middle of August. This probably is the only application which may be needed in addition to those included in the regular spray schedule. Young non-bearing orchards should have a fair amount of arsenical poison on the foliage during the early part of the feeding period of each larval brood; otherwise partial skeletonization if not complete defoliation may occur, and growth will be correspondingly retarded.

In an exceptionally warm and favorable season, or in regions further south, a fourth generation might become of importance, but this is not likely to occur in Connecticut. In 1922 the temperature at New Haven[1] for May was approximately 60° F.; June, 68°

[1] This approximates a mean temperature, is based on records taken at eight o'clock P. M., and was computed on a system worked out by F. Z. Hartzell, Technical Bulletin No. 68, New York Agricultural Experiment Station, Geneva, N. Y., June, 1919.

F.; July, 69° F.; August, 71° F.; September, 68° F.; and October, 62° F.

Summary.

The apple and thorn skeletonizer, an insect well known in Europe for over one and one-half centuries, was discovered in the lower Hudson Valley in 1917, and in southwestern Connecticut in 1920. Since then it has spread up the Hudson to Albany, over nearly the entire State of Connecticut, and into western Massachusetts. Many neglected orchards, small home orchards, and roadside trees have been nearly defoliated by this insect in many parts of Connecticut.

In Connecticut the species passed through three generations during the season of 1922, larvae of the first generation being present on the trees during May and early June; those of the second from late June to early August; and those of the third from August to the middle of October. A very fractional fourth generation started during an unusually warm period in October, but a freeze ruined the food supply before any of the larvae had passed beyond the early instars. Hibernation in the winter of 1922-23 will occur almost entirely in the adult stage; under certain conditions some individuals may hibernate in the pupal stage.

A number of different parasites have been reared from the larvae and pupae of the skeletonizer, for the most part in small numbers. It is to be hoped that these and other natural enemies will increase in numbers and effectiveness, and will in the near future bring this new pest within more reasonable bounds.

The usual spray schedule will ordinarily keep the skeletonizer under control. The third generation will probably cause the most trouble in commercial orchards. In case this brood threatens serious damage, it can be easily controlled by an additional application of arsenate of lead at the rate of one pound of the dry form in 50 gallons of water, put on when the larvae are becoming numerous, the middle to the latter part of August.

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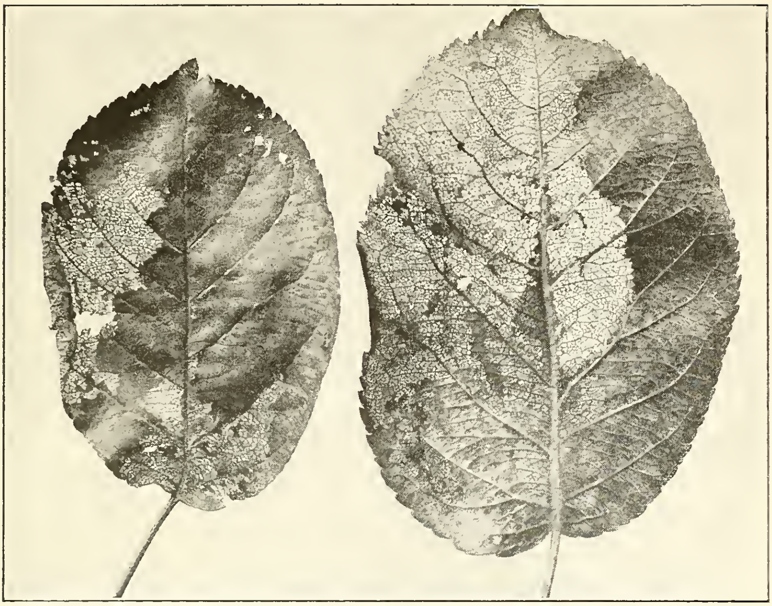
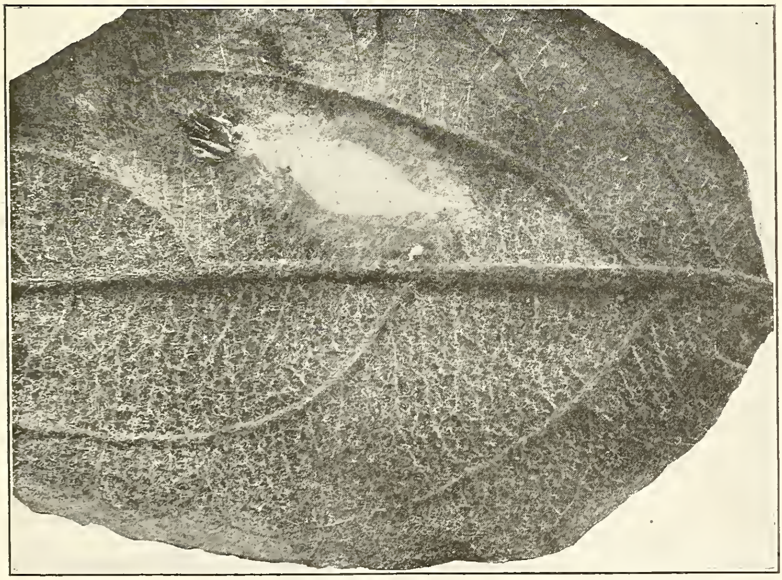
PLATE I.



a. Characteristic injury of larvae on apple leaves, somewhat reduced.



b. Cocoon on under surface of apple leaf, twice natural size.

APPLE AND THORN SKELETONIZER.

PLATE II.

a. Larva, enlarged four times.

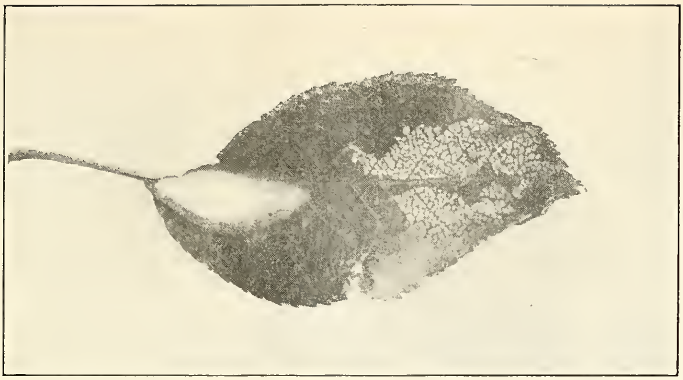
b. Moth resting, enlarged three and one-half times.

c. Pupae, enlarged about five times.

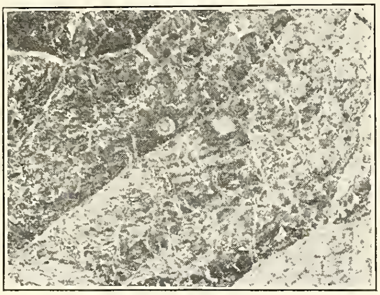
d. Adults, enlarged four times.

APPLE AND THORN SKELETONIZER.

PLATE III.



a. Cocoon on leaf, showing double-walled construction, somewhat reduced.

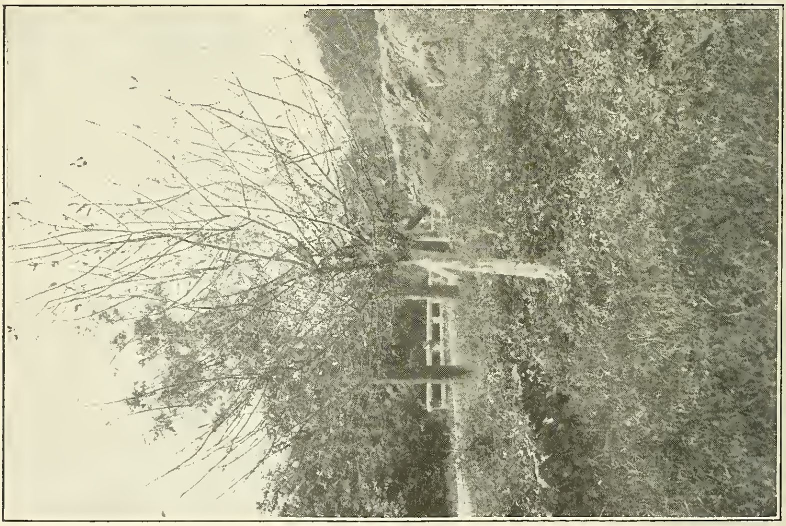


b. Eggs on under surface of leaf, enlarged five times.

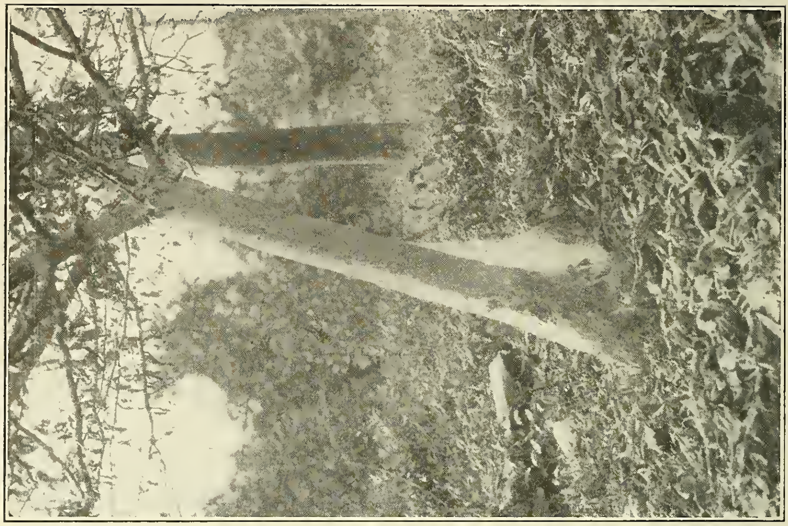
c. Larva on leaf, natural size.

APPLE AND THORN SKELETONIZER.

PLATE IV.



a. Apple tree defoliated by the skeletonizer.



b. Apple tree showing unusual web spun by caterpillars leaving it in search of food.